Geologic Resource Evaluation Scoping Summary
Fort Davis National Historic Site, Texas

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The Geologic Resource Evaluation (GRE) Program provides each of 270 identified natural area National Park System units with a geologic scoping meeting and summary (this document), a digital geologic map, and a geologic resource evaluation report. The purpose of scoping is to identify geologic mapping coverage and needs, distinctive geologic processes and features, resource management issues, and monitoring and research needs. Geologic scoping meetings generate an evaluation of the adequacy of existing geologic maps for resource management, provide an opportunity to discuss park-specific geologic management issues, and if possible include a site visit with local experts.

In an e-mail dated March 13, 2008, Bruce Heise wrote, "Chuck Hunt and I spoke yesterday about scoping Fort Davis as part of our trip in April [i.e., in conjunction with scoping for Amistad National Recreation Area, Palo Alto Battlefield National Historic Site, and San Antonio Missions National Historical Park]. While the park [staff] is extremely interested in getting more knowledge on their geologic resources, the timing for them, given the driving distance and park visitation that time of year, just isn't going to work out." Instead, the Geologic Resources Division hosted a conference call for Fort Davis National Historic Site on April 15, 2008. Participants in the conference call included NPS staff from Fort Davis National Historic Site, Chihuahuan Desert Network, and Geologic Resources Division, as well as cooperators from Colorado State University. Potential cooperators in future scoping also include the Texas Bureau of Economic Geology, U.S. Geological Survey, Sul Ross State University, Baylor University, and University of Texas at El Paso (table 2).

Although the conference call filled an immediate need, the general consensus among those who routinely participate in GRE scoping is that such calls are inadequate for scoping. Therefore, in 2009, as part of the unveiling of the new USGS map produced for the U.S.-Mexico Border Environmental Health Initiative (see http://borderhealth.cr.usgs.gov/) and the release of the new geologic map of Big Bend National Park, GRE staff will coordinate a field trip to Fort Davis National Historic Site. This will address the request from park staff to have some experts give them a geologic tour of the national historic site. Bruce Heise has contacted Dr. Kevin Urbanczyk (Sul Ross State University), who would be willing to assist in leading such a trip. In addition, because Fort Davis is located in a county that is along the border, the USGS border initiative is a potential collaborator in the geologic resource evaluation. Possibly Ric Page (U.S. Geological Survey) could share information about the USGS project along the border with park staff.

Park and Geologic Setting

Authorized in 1961 and established on July 4, 1963, with a boundary change on November 6, 1998, Fort Davis National Historic Site covers approximately 192 ha (474 ac). The site is located in a box canyon near Limpia Creek on the eastern side of the Davis Mountains, the most extensive mountain range in Texas. From 1854 to 1891 when the fort was occupied, trees from the surrounding hills provided wood for fuel, the river and springs provided water, and grass was plentiful for forage. Although most of the buildings at the fort are adobe, the nearby cliffs of red volcanic tuff provided material for foundations (Thybony 1990), as well as stone for the officers' quarters. The source for building materials was the Tertiary volcanics that flank the flat, bajada-like terrain where the fort's parade grounds and buildings rest. Named in honor of U.S. Secretary of War Jefferson Davis, who later became president of the Confederacy, Fort Davis served as a key post in western Texas where soldiers helped to open the area to settlement and protect emigrants, freighters, mail coaches, and travelers along the San Antonio–El Paso Road. When the National Park Service acquired the property in the early 1960s, Fort Davis had been abandoned for nearly 70 years (Thybony 1990). An intensive restoration effort stabilized structures, restored buildings, and refurnished barracks with period antiques, museum-quality replicas, and custom-made items. Restoration efforts are ongoing; for instance, restoration of the post hospital is presently underway (see http://www.nps.gov/foda/forteachers/upload/Post%20Hospital%20@%20FODA.pdf).

Historians consider Fort Davis to be one of the best remaining examples of a frontier military post in the American Southwest. Visitors can take self-guided tours of the restored and refurnished buildings. In addition, hiking trails within the national historic site connect with trails in adjacent Davis Mountain State Park. The exposed igneous rock in the canyon walls records the volcanic activity that formed the Davis Mountains 40–20 million years ago.

Geologic Mapping Plan for Fort Davis National Historic Site

The GRE Program's digital geologic maps reproduce all aspects of paper maps, including notes, legend, and cross sections, with the added benefit of being GIS compatible. The NPS GRE Geology-GIS Geodatabase Data Model incorporates the standards of digital map creation for the GRE Program and allows for rigorous quality control. Staff members digitize maps or convert digital data to the GRE digital geologic map model using ESRI ArcGIS software. Final digital geologic map products include data in geodatabase and shapefile format, layer files complete with feature symbology, FGDC-compliant metadata, a Windows HelpFile that captures ancillary map data, and a map document that displays the map and provides a tool to directly access the HelpFile. Final products are posted at http://science.nature.nps.gov/nrdata/. The data model is available at http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm.

When possible, the GRE Program provides large-scale (1:24,000) digital geologic map coverage for each park's area of interest, which is often composed of the 7.5-minute quadrangles that contain parklands (fig. 1). Maps of this scale (and larger) are useful to resource managers because they capture most geologic features of interest and are spatially accurate within 12 m (40 ft). The process of selecting maps for management begins with the identification of existing geologic maps in the vicinity of the park (table 1). Scoping session participants then discuss mapping needs and select appropriate source maps for the digital geologic data or, if necessary, develop a plan to obtain new mapping.

The largest scale geologic map that GRE staff was able to find to cover Fort Davis National Historic Site was the statewide shapefile of Texas (GMAP 74114) at a scale of 1:100,000. However, the Fort Stockton quadrangle (GMAP 72509) from the *Geologic Atlas of Texas* (GAT) has better detail of the Tertiary volcanic units (i.e., they are not "lumped" together). Therefore, the plan at present is for GRE staff to digitize the GAT Fort Stockton quadrangle to the extent of the Fort Davis 7.5-minute USGS quadrangle. Park staff agreed that data that covers this quadrangle would provide sufficient information for resource management. The Texas Bureau of Economic Geology provided georeferenced scans of this map, but Andrea Croskrey (Geologic Resources Division) suggested obtaining the printed Fort Stockton quadrangle (GMAP 2518) and scanning and georeferencing it in UTM for digitizing.

Igneous Geology of the Central Davis Mountains, Jeff Davis County, Texas (GMAP 43520); *Map of Quaternary Faults in West Texas and Adjacent Parts of Mexico* (GMAP 22634); *Occurrence of Oil and Gas in West Texas* (GMAP 70238); and *Map Showing Outcrops of Basaltic Rocks, Basin and Range Province and Vicinity, Trans-Pecos, Texas* (GMAP 37998) do not have any features that are inside the boundary of the Fort Davis 7.5-minute USGS quadrangle.

Ash-flows from *Map Showing Outcrops of Ash-Flow Tuffs, Basin and Range Province and Vicinity, Trans-Pecos Texas*, Marfa-Fort Stockton sheets (GMAP 74942), do fall in the area of the Fort Davis 7.5-minute quadrangle but are already captured by the 1:250,000-scale Fort Stockton map. To outline a described outcrop on the southern boundary of the Fort Davis 7.5-minute quadrangle, GRE staff will use a similar document—*Map Showing Outcrops and Lithology of Intrusive Rocks, Basin and Range Province and Vicinity, Trans-Pecos Texas*, Marfa–Fort Stockton sheet (GMAP 74940).

Because the largest scale map known to cover the national historic site is 1:100,000, Eddie Collins (Texas Bureau of Economic Geology) recommended contacting Kevin Urbanczyk from Sul Ross State University, Don Parker from Baylor University, and Elizabeth Anthony from the University of Texas at El Paso to see if they know of any larger scale maps in the area. Andrea Croskrey contacted Dr. Kevin Urbanczyk who offered to help the park with interpretive geologic signs (see "Interpretive Plan" section) and mentioned that the Southwestern Association of Student Geological Societies (SASGS) 1991 field guide to the Davis Mountains may have larger scale maps of the area. Andrea Croskrey contacted Dr. Parker at Baylor University about this guidebook (i.e., Parker et al. 1991), which has relevant information such as descriptions of road cuts and a stratigraphic column of regional volcanic rocks but no spatial data for the GRE database. Hence, this guidebook is not a source of data for the digital geologic map, but it will be useful in preparing the final GRE report for the national historic site.

Summary of Mapping Plan

- Digitize Fort Davis–quadrangle portion of GAT Fort Stockton sheet (scale 1:250,000).
- Digitize ash flows for Fort Davis quadrangle (scale 1:250,000).

Table 1. Published Geologic Maps in the Vicinity of Fort Davis National Historic Site

GMAP[1]	Citation	Format	Notes
72509	Texas Commission on Environmental Quality. 2004. *Geologic atlas of Texas*. Scale 1:250,000 scale. Austin, TX: Texas Commission on Environmental Quality.	Clipped, scanned and georeferenced TIFs	Don't use; georef looks rough; get paper copy
74114	Stoeser, D. B., G. N. Green, L. C. Morath, W. D. Heran, A. B. Wilson, D. W. Moore, and B. S. Van Gosen. 2005. *Preliminary integrated geologic map databases for the United States: Central states—Montana, Wyoming, Colorado, New Mexico, Kansas, Oklahoma, Texas, Missouri, Arkansas, and Louisiana*. Scale 1:100,000. Open-File Report OF-2005-1351. Reston, VA: U.S. Geological Survey.	Shapefiles	Don't use; units are generalized
43520	Anderson, J. E. 1968. *Igneous geology of the central Davis Mountains, Jeff Davis County, Texas*. Scale 1:62,500. Geologic Quadrangle Map GQ-0036. Austin, TX: Bureau of Economic Geology.	?	Doesn't cover the park
22634	Collins, E. W., J. A. Raney, M. N. Machette, K. M. Haller, and R. L. Dart. 1996. *Map of Quaternary faults in West Texas and adjacent parts of Mexico*. Scale 1:500,000. Open-File Report OF-96-2. Reston, VA: U.S. Geological Survey.	?	Doesn't cover the park
70238	Herald, F. A. 1957. *Occurrence of oil and gas in West Texas* [compilation of oil field areas]. Scale 1:50,000. Publication PB5716. Austin, TX: Texas Bureau of Economic Geology and West Texas Geological Society.	Paper	Doesn't cover the park
2518	Anderson, J. E. Jr., J. B. Brown, J. C. Gries, E. M. P. Lovejoy, D. McKalips, and V. E. Barnes. 1995. *Geologic atlas of Texas: Fort Stockton sheet*. Scale 1:250,000. GA0016. Charles Laurence Baker Memorial Edition. Austin, TX: Texas Bureau of Economic Geology.	Paper	Digitize for the park if unable to find anything larger scale
74942	Henry, C. D., and G. L. Fisher. 1984. *Map showing outcrops of ash-flow tuffs, Basin and Range province and vicinity, Trans-Pecos Texas*. Sheet 2 of 3. Scale 1:250,000. Water-Resources Investigations Report 83-4121-E. Reston, VA: U.S. Geological Survey.	Paper	Same ash-flow tuffs are shown on the Fort Stockton quad
74940	Henry, C. D., and G. L. Fisher. 1984. *Map showing outcrops and lithology of intrusive rocks, Basin and Range province and vicinity, Trans-Pecos Texas*. Sheet 2 of 3. Scale 1:250,000. Water-Resources Investigations Report 83-4121-D. Reston, VA: U.S. Geological Survey.	Paper	Use for outcrop of geologic unit JD-13, Gorski (1970)
37998	Henry, C. D., and G. L. Fisher. 1984. *Map showing outcrops of basaltic rocks, Basin and Range province and vicinity, Trans-Pecos Texas.* Sheet 1 of 2. Scale 1:250,000. Water-Resources Investigations Report 83-4121-F. Reston, VA: U.S. Geological Survey.	Paper	No units in the Fort Davis 7.5' quad

[1]GMAP numbers are unique identification codes used in the GRE database.

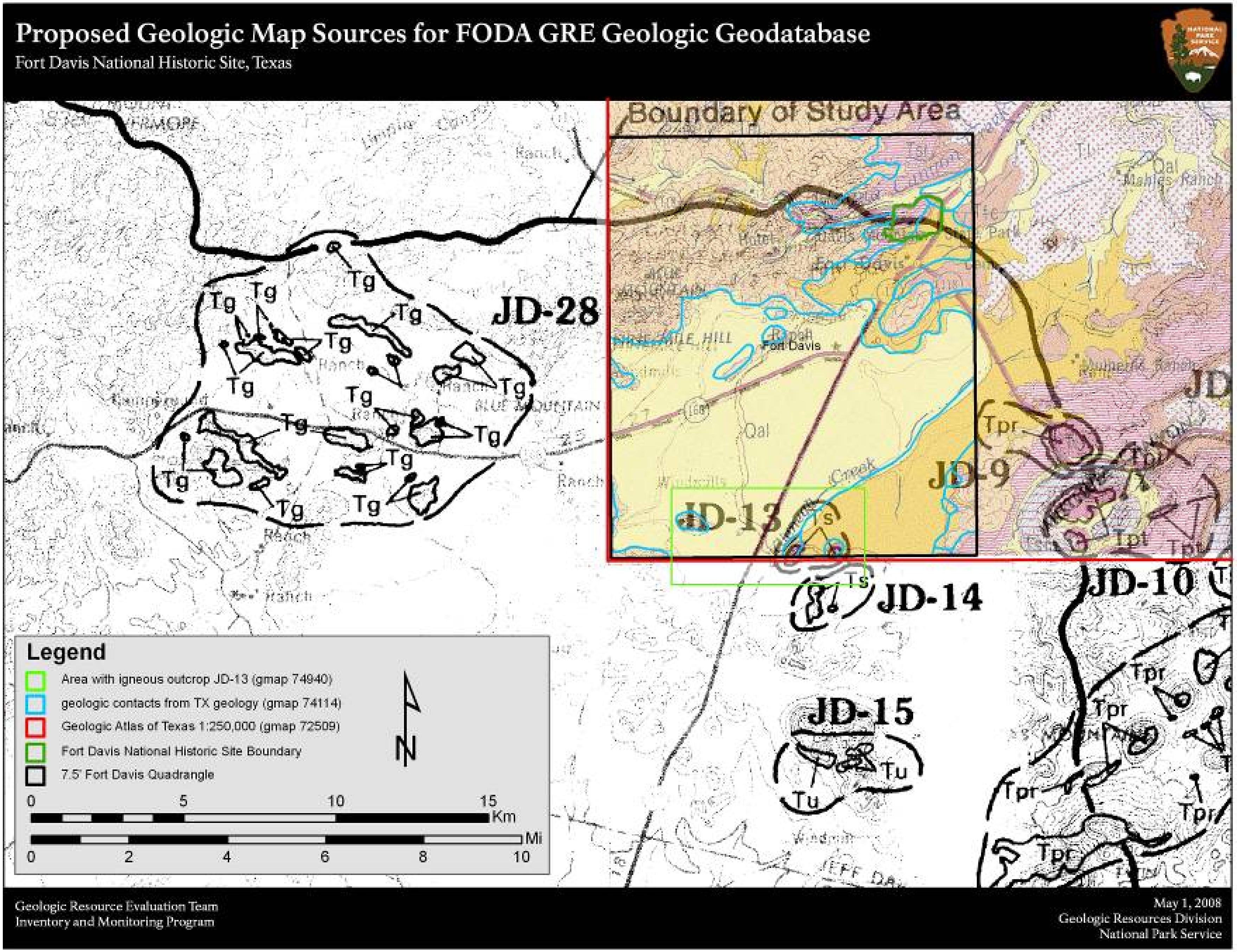

Figure 1. Area of Interest for Fort Davis National Historic Site, Texas. JD = Jeff Davis County sample ID; Tg = Gomez Tuff.

Geologic Features, Processes, and Related Management Issues

During the conference call on April 15, 2008, participants discussed the following geologic features, processes, and related resource management issues. In addition, Eddie Collins (Texas Bureau of Economic Geology) and Katie KellerLynn (Colorado State University) had a supplemental conversation about Fort Davis during the Texas scoping meeting for San Antonio Missions National Historic Park, Amistad National Recreation Area, and Palo Alto Battlefield National Historic Site. Notes from that conversation are incorporated here.

Caves and Karst

Conference-call participants knew of no caves at Fort Davis; however, Eddie Collins thought perhaps some shelter caves may exist in the cliffs flanking the Fort Davis property.

Climate Change

Losing Ground: Western National Parks Endangered by Climate Disruption states, "A climate disrupted by human activities poses such sweeping threats to the scenery, natural and cultural resources, and wildlife of the West's national parks that it dwarfs all previous risks to these American treasures" (Saunders et al. 2006). The authors contend that "a disrupted climate is the single greatest threat to ever face western national parks." Because of the potential disruption that climate change could cause to park resources, including geologic features and processes, the GRE Program has begun to include a discussion of the effects of climate change to park resources during scoping meetings. Drought cycles at Fort Davis may change as a result of climate disruption, which would in turn affect the regularity of dust storms. The region has been experiencing a drought since the 1990s; another such long-term drought occurred during the 1950s.

Disturbed Lands

Modern human activities have disturbed more than 315,000 acres (127,480 ha) in 195 National Park System units. Disturbed lands are those park lands where the natural conditions and processes have been directly impacted by mining, development (e.g., facilities, roads, dams, abandoned campgrounds, and user trails), agricultural practices (e.g., farming, grazing, timber harvest, and abandoned irrigation ditches), overuse, or inappropriate use. The NPS Disturbed Lands Restoration Program, administered by the Geologic Resources Division, usually does not consider lands disturbed by natural phenomena (e.g., landslides, earthquakes, floods, hurricanes, tornadoes, and fires) for restoration unless influenced by human activities. Most disturbances are not in keeping with the mandates of the National Park Service, but some may be of historical significance. For example, the cultural landscape at the fort was much more denuded than today; the Army cut scrub oak and juniper. In addition, the National Park Service is likely to acquire 22 ha (55 ac) to the southwest of Fort Davis National Historic Site. This property may have the quarry exploited for building material at the fort. This quarry would be of historical significance.

Disturbances at Fort Davis National Historic Site may include groundwater mining. In the late 1800s, well levels were 12 m (40 ft); they are approximately 52 m (170 ft) now. In addition, the fort once hosted a spring that no longer produces. Park managers are monitoring groundwater levels and are investigating whether this drawdown is related to development. Another concern for development is protecting the site's viewshed; acquisition of the new property may help preserve views on the southwest boundary.

Commercial logging of ponderosa pine occurs in the Davis Mountains, but resulting erosion and sedimentation does not affect Fort Davis. The sand and gravel resources in the vicinity of Fort Davis are very fine-grained and not suitable for industrial use; historically they may have been used for making mortar, however.

Eolian Features and Processes

Fort Davis National Historic Site hosts no significant dunes or loess deposits. However, dust storms in the spring are common, primarily as a result of disturbed agricultural fields. Not uncommon during these times are “mud storms”—when precipitation mixed with dust “rains” out of the air.

Fluvial Processes and Surface Water

Limpia Canyon through which the first 68 km (42 mi) of Limpia Creek runs was the principal avenue for early exploration and settlement of Jeff Davis County (The Handbook of Texas Online at http://www.tshaonline.org/handbook/online/articles/LL/rbl50.html). Limpia Creek originates on the northeastern flank of Mount Livermore, the highest peak in the Davis Mountains (2,555 m [8,382 ft]), which is 27 km (17 mi) northwest of Fort Davis. The river then flows along the national historic site’s boundary and runs northeast for 101 km (63 mi) to its mouth on Barrilla Draw in western Pecos County. Limpia Creek used to flow onto Fort Davis property, but seismic activity in 1950 redirected its flow. The creek’s upper reaches cross rugged terrain surfaced by shallow, stony soils. The lower reaches run through flat to rolling country surfaced by shallow, stony clay and sandy loams. During occupation of the fort, Army soldiers built a dam and dike system to divert the water from Limpia Creek. This is a cultural feature that park managers maintain and use.

Arroyos have cut the bajada-like alluvial plain on which Fort Davis sits. During monsoon season, water pours off the volcanic cliffs and flows onto fort property. Typically, flows last for a few hours. Some have caused flooding; for example, in 1990 storm flow impacted some buildings at Fort Davis. At the western end of the national historic site, tinaja-like depressions hold water that pours off the cliffs during storms.

A cottonwood grove indicates the existence of a former spring, and wetland-type soils document former wetter times. Fort Davis National Historic Site is in the NPS Soils Program’s queue for a soils map. Park managers may contact Pete Biggam (Geologic Resources Division) at 303-987-6948 or pete_biggam@nps.gov for more information.

Geothermal Features and Processes

The nearest geothermal area is a few hours south of Fort Davis along the Rio Grande (i.e., near Big Bend National Park).

Hillslope Features and Processes

The cliffs in the vicinity of the fort are a minimal threat for rockfall hazards. Some colluvial debris has formed deposits at the base of these cliffs, but the volcanic rock (i.e., rhyolites or ignimbrites) show few signs of instability.

Seismic Features and Processes

Periodically visitors and staff feel seismic shaking at Fort Davis. Notable seismic activity occurred in the 1950s, diverting Limpia Creek, which at the time flowed on the property that is now Fort Davis National Historic Site. Although this event changed the hydrologic pattern, it left no other surface expression. In spring 1995 a 5.0-magnitude earthquake (on the Richter scale) occurred near Marathon, Texas (epicenter east of Alpine, Texas); this is the most significant recent earthquake in the vicinity of the national historic site. *Map and Data for Quaternary Faults in West Texas and Adjacent Parts of Mexico* (Collins et al. 1996) covers faults that are west of the Davis Mountains; however, descriptions of the geology might be useful in preparing the final GRE report (see Henry and Price 1985; Collins and Raney 1997). Conference-call participants mentioned that Mike Machette at the U.S. Geological Survey completed a seismic map for the area.

Unique Geologic Resources

Unique geologic resources include natural features mentioned in a unit's enabling legislation, features of widespread geologic importance, geologic resources of interest to visitors, and geologic features worthy of interpretation. The GRE Program also considers type localities and age dates as unique geologic resources. No known type sections occur within the national historic site, but adjacent Davis Mountains State Park may contain one.

Volcanic Features and Processes

Volcanic activity surrounding Fort Davis ended 20 million years ago. However, most of rock types that will appear on the digital geologic map are volcanic: rhyolite, tuff, basalt, and sedimentary deposits between flows. Some units may be particularly interesting and enjoyable to interpret, for example, ignimbrites—rock formed by the widespread emplacement of ash flows and swiftly flowing nuées ardentes. In addition, the Davis Mountain volcanic field and Buckhorn Caldera express a violent geologic past and may be of interest to visitors.

Interpretive Plan

Staff at Fort Davis National Historic Site would like to incorporate geology into the interpretive plan and are seeking assistance from experts. Interpretive materials would include a trail guide and wayside signs. Kevin Urbansik (Sul Ross State University, Texas), Don Parker (Baylor University), and Elizabeth Anthony (University of Texas at El Paso) are experts of the local geology who may be willing to assist the National Park Service. In addition, Lisa Morgan (U.S. Geological Survey), who has worked in Yellowstone and Big Bend national parks and Craters of the Moon National Monument, is interested in the volcanic geology and "story" of Fort Davis. Bruce Heise (Geologic Resources Division) believes that the GRE Program could fund a portion of Lisa's salary and travel costs to work with staff at the national historic site in fiscal year 2009.

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Table 1. Geologic Resource Evaluation (GRE) Scoping Cooperators for Fort Davis National Historic Site

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*Participated in conference call on April 15, 2008.